Prevalence of Iron Deficiency Anemia among Adolescent School Children of Manipur, India

Abstract

Background: Iron deficiency anemia (IDA), one of the most common types of nutritional anemia worldwide is considered a major public health problem in developing countries. Prevalence in India remains alarmingly high. Population of Manipur, a small state in the north-eastern part of India, is different with distinct race, culture, socio-demographic pattern and dietary habits. Therefore, this cross-sectional study was conducted to determine the prevalence and risk factors of IDA among apparently healthy school children of Manipur, India.

Method: Three hundred and seventy-nine blood samples (163 males and 216 females) were collected randomly from urban and rural school children in the age group of 13 to 19 years from Imphal west and Thoubal districts of Manipur respectively. Eligible participants were subjected to haemoglobin (Hb) estimation and serum ferritin (SF) assay. Moreover, a questionnaire was designed to collect demographics, food and drink habits, hygienic practices and socioeconomic status. BMI of the students were also recorded.

Result. The overall prevalence of IDA was 23.2% (n = 88), of whom 81.81% were females (n = 72) and 18.18% were males (n = 16). Prevalence of IDA among the males and females was higher in the rural compared to urban schools but not statistically significant. Correlation between BMI and Hb was significant ($p < 0.05$) but not with serum ferritin status. Students belonging to the middle income group had the highest prevalence of ferritin deficiency followed by the high income group and low income group respectively. Both the Hb and serum ferritin levels of students who do hand wash before meals were significantly higher than those who do not. Both hemoglobin and serum ferritin levels do not differ significantly among students who prefer home-made traditional food and junk food.

Conclusion: This study revealed that the majority of the students, especially females, have IDA that might become worse by malnutrition, lifestyle habits, and lack of awareness. Our results suggest that IDA can be prevented by providing proper knowledge on the healthful diet, improved lifestyle, and harmful effect of IDA to the students.

Key words: IDA, school children, Manipur

1. Introduction

Iron deficiency anemia is the most common cause of anemia in the world.[1] According to WHO report in 2001, around two billion individuals have been estimated to suffer from anemia out of which 50% of cases have been documented as IDA.[2] The proportion of anaemia caused by iron deficiency in south Asia is 54.8%. Previous studies in India have shown that the prevalence of anaemia varies between 46% and 88% and 50 % of those cases have been reported as IDA. Most of the previous studies on anemia in India were conducted on school children and pregnant women and their predictive factors. However, there is limited information about the prevalence and risks factors of IDA among the Indian adolescent school children.

IDA results from long-term negative iron imbalance. Usually, deficiency of iron develops gradually and does not have clinically apparent symptoms until anemia becomes severe.[3] IDA in adolescence may lead to impairment in learning, intellect and work performance.[3,4]

Haemoglobin and ferritin are considered by World Health Organization to be the most effective indices for determining the population burden of Iron deficiency anaemia.[5] According to WHO, IDA is defined when haemoglobin concentration is less than 13g% in an adult male, 12g% in an adult female or 11.5g% in a child between 5-11 years in combination with a serum ferritin concentration less than 30µg/L in an adult or 20µg/L in a child.[2]

Iron in the form of heme is vital to many metabolic functions including oxygen transportation in haemoglobin. The liver, which is the site of production of iron transport proteins, contains the largest non-functional iron stores either as ferritin or hemosiderin[2,5]. Ferritin is both diffuse and soluble, and is the primary iron storage protein[.6, 7] Dietary iron is absorbed mainly in the duodenum.[7, 8]. Only ferrous iron is absorbed, and it is transported across the apical membrane of the enterocyte by a divalent metal transporter. It is then transferred across the enterocyte to the basolateral membrane by an unknown mechanism.[4,6]

Good dietary sources of iron are liver, iron-enriched breakfast cereal, roast beef, steak nuts (cashews, almonds), roast lamb sweet corn, potato, eggs lentils, baked beans in sauce, bean soup, chilli with beans, dark-flesh tuna whole-grain foods (oatmeal, sunflower seeds),lean pork, ham enriched bread, mostly wholemeal, skinless chicken, green leafy vegetables (broccoli, spinach, cabbage),turkey milk chocolate, white fish, dried fruit (prunes, apricots, raisins),fresh fruit and soy (tofu, soybeans, soymilk).[9]

IDA is a preventable and treatable nutritional disease. Adolescent children are more vulnerable to develop iron deficiency anemia due to accelerated increase in requirements for iron, poor dietary intake of iron, high rate of infection and worm infestation as well as the social norm of early marriage and adolescent pregnancy. Adolescents frequently consume snacks prepared from refined cereals and have a habit to consume carbonated drinks while there is a lower inclination to eat fruits and vegetables.

Manipur is a small state in the north-eastern part of India but the race, culture, socio-demographic pattern and dietary habits are different from the rest of the country. There is paucity of studies on the subject in the region. Thus the current study aims to determine the prevalence and determinants of IDA among adolescent school children in Manipur, India.

2. Methodology

Study design: This a cross-sectional study designed to determine the prevalence of IDA among adolescent school children by analysing blood samples to estimate haemoglobin (Hb) and serum ferritin (SF). Moreover, a pre-designed proforma was used to collect personnel information related to socio-economic status, life-style, dietary habit, hygienic practices before meals and clinical examination findings of the participants. The study was conducted by the Departments of Physiology and Department of Bio-chemistry, Regional Institute of Medical Sciences (RIMS), Imphal in collaboration with selected government and private Secondary and Senior Secondary schools in Imphal West (urban) and Thoubal districts (rural) of Manipur, India between November 2015 – September 2017.

2.1 Study Population:

The present study included 379 adolescent school children of both sexes belonging to rural and urban schools in the age group of 13 to 19 years in Imphal west and Thoubal districts of Manipur. The protocol of this study was approved by the Research Ethics Board, Regional Institute of Medical Sciences, Imphal, Manipur.

2.2 Data and Sample Collection

The pre-designed proforma was used to collect demographic profile, socioeconomic information, hygienic practices, food preferences, history of past and present illnesses and clinical examination findings of the participants. 5 ml of venous blood was collected from each student and divided into two tubes (2ml in the EDTA vial for hemoglobin estimation and 3ml into a plain vial for serum ferritin (SF) assay based on WHO guidelines to confirm the diagnosis of IDA.

2.3 Haematological and Biochemical Parameters

Hemoglobin (Hb) estimation was done using cynamethaemoglobin using EI Digital photo colorimeter model no.312. Hb levels lower than cut-off values were considered to be anaemic (Hb < 13.0 g/dl for male and Hb < 12.0 g/dl for female). Serum Ferritin (SF) estimation was done using Accubind ELISA Microwells in ELISA micro plate reader SR No.-120710 Lisa scan EM. SF < 30 μg/L were considered iron deficient.

2.4 Statistical Analysis

Statistical analysis of the data was done using Statistical Package for Social Sciences (SPSS) version 21. Continuous variables were presented as mean and standard deviations. Data were analysed by using descriptive statistics i.e. mean, percentage and standard deviation. Inferential statistics i.e. Chi-square test and student t-test were employed to assess the association of iron deficiency anaemia with the variables of interest like sex, BMI, socio-economic status, menstrual history, hygienic hand wash practice before food, dietary habits, fear of gaining weight etc. A p value < 0.05 was considered significant.

3. Results

3.1 Prevalence of anemia among students

A total number of 379 blood samples were screened for anemia. Cross-tabulation was performed to describe the association between IDA and gender, foods and drink habits, household income, and social habits.

Prevalence of anaemia in the study population was found to be 36.4%, out of which 23.2% was IDA. Prevalence of anaemia and IDA among the female study population was 50% (108/216) and 33.3% (72/216) respectively while among the male study population, it was 31.2% (51/163) and 9.8% (16/163) respectively.

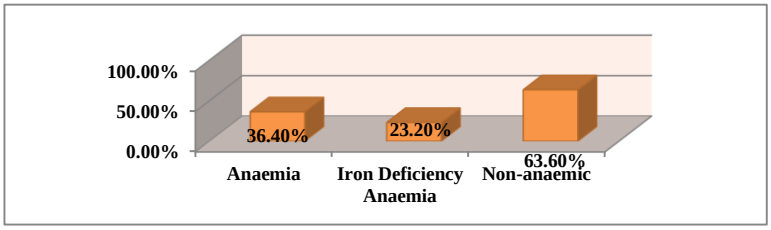

Fig.1 Distribution of Anaemia and Iron Deficiency Anaemia in the study population (n=379)

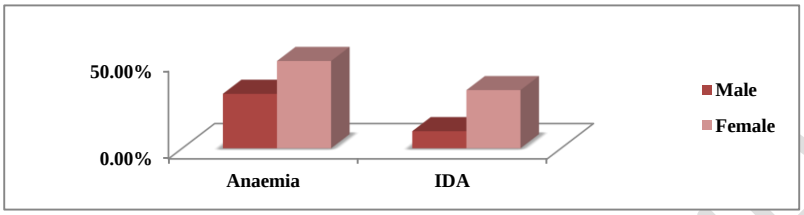

Fig.2 Gender distribution of IDA among adolescent school children (n=379)

Table 1 illustrating highly significant (p-value < 0) mean Hb and SF levels among the male and female students.

Table 1: Comparison of Hb and Ferritin among Male and Female students (n=379)

Parameters	Type	Mean	S.E. of Mean	p-value (t-test)	Remark
Hb(gm/dl)	**Male**	13.64	0.15	**0.00**	Highly significant
	Female	11.72	0.13		
SF (µg/l)	**Male**	71.9	5.1	**0.00**	Highly significant
	Female	37.7	3.5		

Table 2 illustrating no significant mean Hb level but significant SF levels among rural and urban students

Table 2: Comparision of Hb and SF between Rural and Urban study population (n=379)

Parameters	Type	Mean	S.E. of Mean	p-value (t-test)	Remark
Hb(gm/dl)	**Rural**	12.36	0.14	0.101	Insignificant at 5% CI
	Urban	12.74	0.18		
SF (µg/l)	**Rural**	37.7	1.9	**0.00**	Highly significant
	Urban	68.7	6.0		

Table 3 and 4 illustrating no significant difference in mean Hb and SF levels of government and private schools in rural areas but highly significant difference in the urban areas (p-value<0.05).

Table 3: Comparison of Hb level between Govt. and private school students (n=379)

Type	Mean Hb (gm/dl)	S.E. of Mean	p-value (t-test)	Remark
Rural Govt.	12.14	0.20	0.11	Insignificant at 5% CI
Rural Private	12.59	0.19		
Urban Govt.	12.08	0.26	**0.00**	Highly Significant at 5% CI
Urban Private	13.5	0.21		

Table 4: SF level between Govt. and private school students (n=379)

Type	Mean SF (µg/l)	S.E. of Mean	p-value (t-test)	Remark
Rural Govt.	34.5	2.97	0.106	Insignificant at 5% CI
Rural Private	40.7	2.48		
Urban Govt.	82.76	9.07	**0.01**	Highly Significant
Urban Private	52.82	7.27		

Table 5 showing no statistically significant mean Hb and SF levels of male and female study participants with IDA between the urban and rural areas. ($p > 0.05$)

Table 5: Female IDA Rural / Urban Comparision

Rural/Urban	IDA Females	Percent	P-value	
			Hb	Ferritin
Rural	50	69.4	0.23	0.59
Urban	22	30.6		
Total	72	100.0		

Table 6: Male IDA Rural / Urban Comparison

Rural/Urban		N	Mean	Std. Deviation	p-value
Ferritin	Rural	11	15.2455	5.37668	0.16
	Urban	5	11.0600	5.15150	
Hb	Rural	11	11.5000	.95812	0.24
	Urban	5	10.7400	1.55820	

Table 7 showing statistically significant mean Hb and SF level of female study participants with IDA between the government and private schools. ($p < 0.05$)

Table 7: Female IDA Government / Private schools Comparision

			p-value

School	IDA Females	Percent	Hb	Ferritin
Government	50	69.4	**0.044**	**0.049**
Private	22	39.6		
Total	72	100		

Table 8 showing no statistically significant difference in the mean Hb and SF levels among the students of both the private and government schools

Table 8: Male IDA Government / Private school Comparision

Govt./Private		N	Mean	Std. Deviation	p-value
Ferritin	Government school	5	14.5800	7.29671	0.76
	Private school	11	13.6455	4.89374	
Hb	Government school	5	10.9600	1.69204	0.50
	Private school	11	11.4000	.93595	

Table 9 showing significant correlation between BMI and Hb but not with SF

Table 9: Correlation analysis of BMI with Hb and Ferritin (n=379)

BMI With	Correlation	p-value (Chi-square)	Remark
Hb	0.125	**0.015**	Significant
Ferritin	0.09	0.77	Not Significant

Table 10 and table 11 showing strong association between family income with severity of anaemia and SF deficiency with medium income group

Table 10: Income and Hb Level (n=379)

Income	Hb Level				Total
	Severe	Moderate	Mild	Normal	
Upto 5000	1(0.3%)	3(0.8%)	16(4.2%)	19(5.0%)	39(10.3%)
5000 - 10000	4(1.1%)	22(5.8%)	48(12.7%)	122(32.2%)	196(51.7%)
10000 above	0(0.0%)	7(1.8%)	37(9.8%)	100(26.4%)	144(38.0%)
Total	5(1.3%)	32(8.4%)	101(26.6%)	241(63.6%)	379(100.0%)

Chi-square p-value = 0.047 (Significant)

Table 11: Ferritin Group and Income (n=379)

Ferritin Group	Income Range/month	Total

	Upto 5,000	5,000-10,000	>10,000	
Deficient	26(6.9%)	74(19.5%)	43(11.3%)	143(37.7%)
Normal	13(3.4%)	122(32.2%)	101(26.6%)	236(62.3%)
Total	39(10.3%)	196(51.7%)	144(38.0%)	379(100.0%)

Chi-square p-value = 0.00 (Highly significant)

Table 12 showing significantly higher Hb and SF level among students who do hand wash than those who do not.

Table 12: Comparison of Hb and Ferritin levels among Students who do hand wash and do not hand wash (n=379)

Category	Hand Wash	Mean	Std Error	p-value
Hb	Yes	12.65	0.11	0.00
	No	11.19	0.32	
Ferritin	Yes	54.08	3.35	0.00
	No	32.03	5.47	

Table 13 showing no significant difference in Hb and SF level among students who prefer either home-made traditional or junk food.

Table 13: Food preference and mean Hb and S.ferritin levels

Category	Food Preference	Mean	Std Error	p-value
Hb	Home-made traditional food	12.51	0.15	0.69
	Junk	12.60	0.17	
Ferritin	Home-made traditional food	55.49	4.03	0.22
	Junk	47.67	4.93	

4. Discussion

Anemia is defined as a pathological process in which erythrocyte hemoglobin and concentration of red blood cells per unit volume of blood are abnormally low compared to the peripheral blood parameters of a reference population. Iron deficiency is defined by a reduction in ferritin levels that generally results from a diet in which the bioavailability of iron is inadequate or from an increased need for iron during a period of intense growth (pregnancy, adolescence and infancy). Decreased ferritin levels may also be the consequence of extensive blood loss, either in haemorrhagic conditions or in cases of occult bleeding, or following inflammatory processes caused by various chronic diseases.

In the present study, the overall prevalence of anaemia in the adolescent study population was found to be 36.4% out of which 23.2% were iron deficiency anaemia.

Prevalence of anaemia and iron deficiency anaemia among the female study population was 50% (108/216) and 33.3% (72/216) respectively while among the male study population, it was 31.2% (51/163) and 9.8% (16/163) respectively. This difference may be attributed to the higher biological requirement of iron among females in adolescence, lower total food intake and due to menstrual blood loss. Similar results have been described by Rakesh SP[10] in Kollam Kerala where 77.5% of female

adolescents were anaemic compared to 67% in males. In a study in south west Ethiopia by Tesfaye M et al[11] among school going adolescent girls, the odds of anaemia was 3.04 (1.41-6.57) among females compared to males. The prevalence findings of the present study is also consistent with a study done by Anna Ch et al[12] in three aboriginal Canadian communities in which they found that the prevalence of anemia was 36.0% out of which 27.6% were iron deficiency anaemia. However, prevalence is lower compared to a study done by Soman SK et al.[13] in Kerala, India where they found the overall prevalence to be 53.5% and female and male prevalence to be 62.0% and 46.1% respectively. This could be due to better socio-economic conditions and non-vegetarian diet which were reported by the majority of the participants in the present study. The findings of the present study, however, were not consistent with a study done by Jamali NH et al.[14] in Saheedabad, Pakistan in which the overall prevalence was found to be 43.1% and female and male prevalence to be 30.4% and 12.7% respectively. Although the overall prevalence of anaemia was higher in their study, the female and male prevalence were lower compared to the present study. In another study done by Bharati P et al.[15] on burden of anemia and its socioeconomic determinants among adolescent girls in India, they found that the lowest prevalence rates of anemia were found in the north-eastern states of India.

In the present study, mean Hb and SF levels of government and private school students do not differ significantly in the rural areas. However, mean Hb and SF levels of government school students were found to be significantly lower than the private school students in the urban areas. This finding could be due to considerable difference in the socio-economic standard of the students in government and private schools in urban areas compared to rural areas. Private schools in urban areas are highly expensive compared to those in the rural areas.

In the present study, Hb level among rural and urban students do not differ significantly ($p > 0.05$) but SF level of urban students is significantly higher than rural students ($p < 0.05$). This finding could be due to the lack of awareness on the importance of consuming iron-rich food, poor habit of maintaining hygiene among the rural adolescent school students and socio-economic disparity between the rural and urban school students.

In the present study, male study population had a mean Hb level of 13.64 ± 0.15 g/dL and mean SF level of 71.9 ± 5.1µg/L while the female study population had a mean Hb level of (11.72 ± 0.13 g/dL) and a mean SF of 37.7 ± 3.5 µg/L. The findings are found to be highly significant statistically (p-value < 0)

In the present study, level of Hb and serum ferritin among adolescent female IDA students in government schools were highly significant compared to female IDA students in private schools ($p< 0.5$)

In the present study, BMI of students were positively correlated with Hb levels and serum ferritin levels respectively. However, BMI status was significantly correlated with Hb level compared to serum ferritin level. This finding is supported by a study done by Ramzi M et al.[16] on anemia and iron deficiency in adolescent school girls in Kavar urban area Southern Iran, where they concluded BMI is one of the factors influencing haemoglobin concentration. The finding is also supported by studies done by Premalatha T et al.[17] in Chennai and Keikhaei B et al.[18] However, a study done by Kaur S et al.[19] in rural Wardha, Maharashtra, India, found that BMI did not contribute significantly to anaemia.

In the present study, the prevalence of anemia among adolescent students in low socio-economic group (low income, middle income) and high socio-economic group (high income) were found to be (5.3%, 19.6%) and 11.6% respectively. This finding is consistent with a study done by Shatha S et al.[20] in Baghdad in which they found the prevalence to be 17.6% in Low Socio Economic Area and

12.9% in high socio-economic area. Studies done by Sanjeev Chaudhary M and Vasant Dhage R[21] and Vitull K et al.[22] in India also supported this finding.

In the present study, comparison of Hb and SF levels of the students who do and who do not hand wash before food is highly significantly (p=0) showing that there is a strong positive correlation between the lack of practice of regular hand-washing before food and iron deficiency anaemia. This finding is consistent with the finding of a study done by Pravin NY et al[23] in urban slum area in South India which revealed that the practice of hand washing before eating main meals play a role in the prevalence of anaemia among adolescent boys.

The present study concluded that the Hb and SF level do not differ significantly among students who prefer home food or junk food ($p > 0.05$). This suggests that the home-made traditional food and junk food preferences have no significant contribution towards development of iron deficiency anaemia.

5. Conclusion

In the present study, prevalence of anaemia among the adolescent school children of Manipur is lower compared to other studies done in India. Percentage of Iron deficiency anaemia among the anaemic school children was found to be high in the present study. The mean haemoglobin and serum ferritin levels were found to be significantly lower in female students of government schools when compared to female students of private schools. There was no significant correlation between mean haemoglobin and SF levels among school children of urban and rural schools. Prevalence of iron deficiency anaemia was higher among the female students compared to the male students. Iron deficiency anaemia was found to be positively correlated with BMI, monthly family income and hand washing practices before food in the present study. Food preferences of the students showed no strong correlation with iron deficiency anaemia.

Information, Education and Communication (IEC) activities regarding personal hygiene and promotion of healthy nutritional practices are recommended to be part of the academic curriculum. Promotion of proper utilization of iron and folic acid supplementation via Weekly Iron and Folic Acid Supplementation (WIFS) programme and biannual deworming are also recommended. Annual screening for anemia along with health education and poverty alleviation program would definitely aid in developing strategies and programs to improve adolescence health by ensuring adequate micronutrient store for prevention of nutritional anaemia in general and iron deficiency anaemia in particular.

References

1. Al-Zabedi EM. Prevalence and Risk Factors of Iron Deficiency Anemia among Children in Yemen. Am J Health Res 2014;2(5):319.

2. WHO/UNICEF/UNU. Iron deficiency anemia: assessment, prevention, and control. World Health Organization, Geneva, 2001.

3. Shill KB, Karmakar P, Kibria MG et al. Prevalence of iron-deficiency anaemia among university students in Noakhali Region, Bangladesh. J Health Popu and Nutr. 2014;32(1):103–110.

4. Oski FA. Iron deficiency in infancy and childhood. New Eng J Med. 1993;329(3):190–93.

5. World Health Organization and Centres for Disease Control and Prevention. Assessing the iron status of population. Geneva: World Health Organization/Centres for Disease Control and Prevention; 2007.

6. Que L. Interpreting serum ferritin. In: Steve FB, Kerri P, Linda C, Cheree C editors. Common sense pathology. Chatswood DC: Cirrus Media; 2013. p. 5.

7. Crichton R. Iron Metabolism: From Molecular Mechanisms to Clinical Consequences. 3rd ed. West Sussex (UK): John Wiley and Sons; 2009. p. 141–325.

8. Knovich MA, Storey JA, Coffman LG, Torti SV, Torti FM. Ferritin for the clinician. Blood Rev 2009;23(3):95–104.

9. Burke & Deakin, Rockwell & Hinton. American Dietetic Association (ADA). Nutrition and athletic performance—Position of the American Dietetic Association, Dieticians of Canada, and the American College of Sports Medicine. J Am Diet Assoc 2005;100:1543–56.

10. Rakesh P S. Anemia among school children from a rural area in Kollam District, Kerala. Kerala Med J. 2014;3(15):359-63.

11. Tesfaye M, Yemane T, Adisu W, Asres Y, Gedefaw L. Anemia and iron deficiency among school adolescents: Burden, Severity, and Determinant factors in southwest Ethiopia. Adolesc Health Med Ther. 2015;6:189–96.

12. Anna Ch, Claudia S, Stanley H, Zlotkin. Iron deficiency anemia prevalence and associated etiologic risk factors in first nations and Inuit communities in northern Ontario and Nunavut. Can J Public Health 2005;96(4):304-7.

13. Soman SK, Binu A, Asha JM, Rosin GV. Adolescent anaemia its prevalence and determinants: a cross-sectional study from south Kerala, India. Int J Community Med Public Health. 2017;4(8):2750-56.

14. Jamali NH, Mahesar H. and Bhutto MA. Prevalence of Iron Deficiency Anaemia in School and College Going Students of District Shaheed Pakistan. Open J of Blood Diseases. 2016;6:67-78.

15. Bharati P et al. Burden of anemia and its socioeconomic determinants among adolescent girls in India. Food and Nutrition Bulletin The United Nations University. 2009; 30(3).

16. Ramzi M, Haghpanah S. Anemia and Iron Deficiency in Adolescent School Girls in Kavar Urban Area, Southern Iran. Iran Red Crescent Med J 2011;13(2):128–33.

17. Premalatha T, Valarmathi S, Srijayanth P, Sundar JS, Kalpana S. Prevalence of anemia and its associated factors among adolescent school girls in Chennai, Tamil Nadu, India. J Epidemiol Res 2012;2:118.

18. Keikhaei B, Askari R, Aminzadeh M. Adolescent with unfeasible Body Mass Index: A Risk Factor for Iron Deficiency Anemia. J Health Med Informat 2012;3:109.

19. Kaur S, Deshmukh P, Garg B. Epidemiological correlates of nutritional anemia in adolescent girls of rural Wardha. Indian J Community Med 2006;31(4):255-8.

20. Shatha S, SharbattAli, Nada J, Dhia J. Timimi Al. Anemia among adolescents. Saudi Med J 2003;24(2):189-94.

21. Sanjeev Chaudhary M, Vasant Dhage R. A study of anemia among adolescent females in the urban area of Nagpur. Indian J Community Med 2008;33(4):243–5.

22. Vitull K, Arun KM, Rajiv K, Jagjeet SB, Sonia A et al. To study the prevalence of anaemia in young males and females with respect to the age, body mass index, activity profile and the socioeconomic status in rural Punjab. J Clin Diagn Res 2011;5(5):1020-6.

23. Vitull K, Arun KM, Rajiv K, Jagjeet SB, Sonia A et al. To study the prevalence of anaemia in young males and females with respect to the age, body mass index, activity profile and the socioeconomic status in rural Punjab. J Clin Diagn Res 2011;5(5):1020-6.